# Mole Problems

The concept of a mole is an important one for chemistry. While we work with grams or millilitres in human terms, using chemical substances, chemical reactions happen among molecules. We use moles to perform calculations about reactions, and that means we have to translate our human measurements into moles and back again to know what's going on in the lab.

A mole is $6.022 \times 10^{23}$ of something. For a metal, like silver, a mole represents $6.022 \times 10^{23}$ atoms of silver. For molecular compounds, like carbon dioxide, a mole is $6.022 \times 10^{23}$ molecules. For an ionic substance in solution, a mole is $6.022 \times 10^{23}$ of any ion that results from dissociation.

*Example 1:* Determine the number of molecules in 5.25 moles of water ($H_2O$).

*Solution:* Since a mole is a fixed number of molecules, we can use a simple conversion fraction to calculate the answer:

$$5.25 \text{ mol } H_2O \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol}} = 3.16 \times 10^{24} \text{ molecules } H_2O$$

*Example 2:* Determine the number of moles of sodium ions in 0.565 moles of $Na_2SO_4$.

*Solution:* When sodium sulfate dissociates, it produces two $Na^+$ ions, so:

$$0.565 \text{ mol } Na_2SO_4 \times \frac{2 \text{ Na}^+ \text{ ions}}{1 Na_2SO_4 \text{ "molecule"}} = 1.13 \text{ mol } Na^+$$

When we are asked to convert grams into moles, we need to find the **molar mass** of the substance in the question, using the periodic table.

*Example 3:* Determine the number of moles in 78.5 g of potassium benzoate ($C_7H_5KO_2$).

*Solution:* First, we need the molar mass of potassium benzoate. We calculate this by adding the atomic weights of all the atoms in the molecule:

| | |
|---|---|
| hydrogen | 1.008 |
| carbon | 12.011 |
| oxygen | 16.000 |
| potassium | 39.098 |

(7 carbon) + (5 hydrogen) + (1 potassium) + (2 oxygen)
= (7 × 12.011) + (5 × 1.008) + (39.098) + (2 × 16.000)
= 160.215 $g_{mol}$

We can now use this as a conversion fraction to find the number of moles:

$$78.5 \text{ g } C_7H_5KO_2 \times \frac{1 \text{ mol } C_7H_5KO_2}{160.215 \text{ g } C_7H_5KO_2} = 0.490 \text{ mol } C_7H_5KO_2$$



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